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GENERAL REFINING SITE REMOVAL ACTION

Garden City, Chatham County, Georgia

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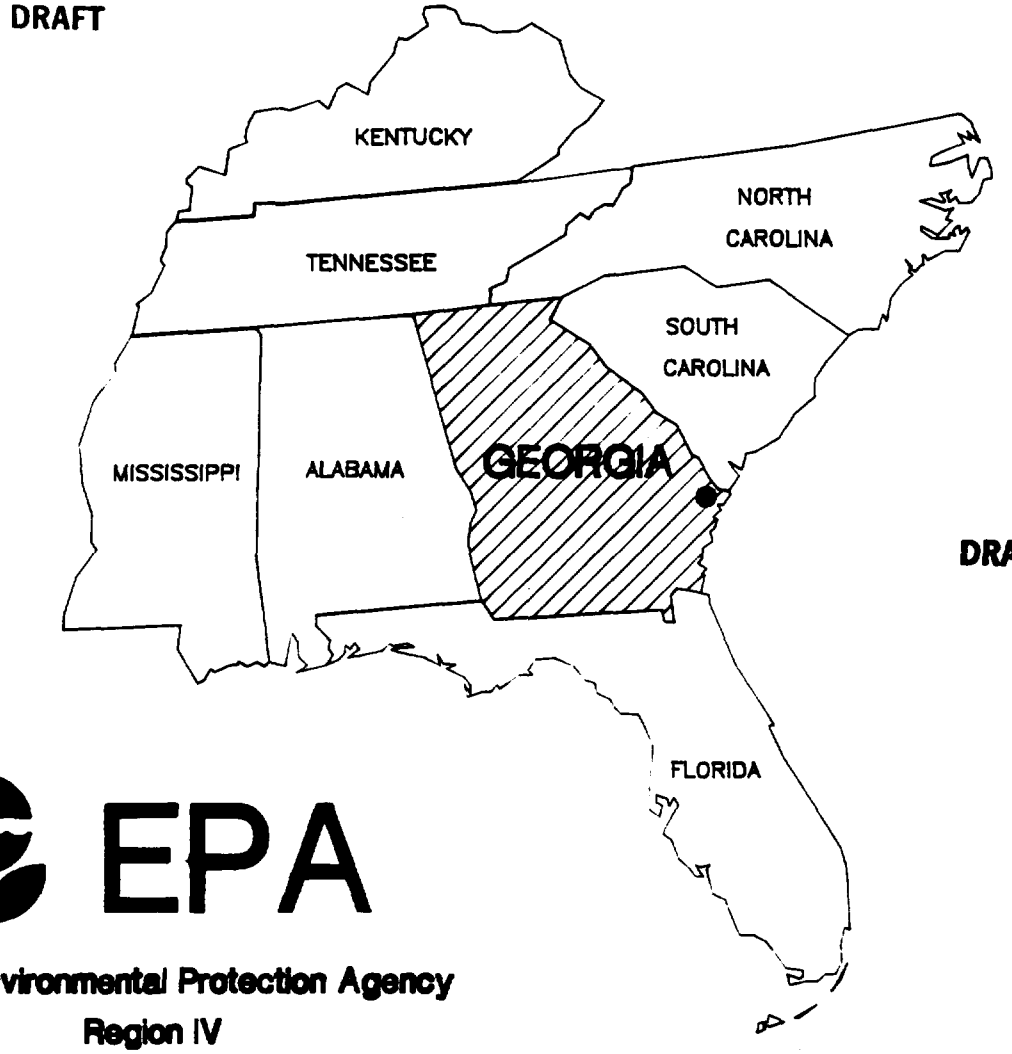

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EPA

U.S. Environmental Protection Agency
Region IV
Atlanta, Georgia

OSC Report

~~REPORT OF REMOVAL ACTIVITIES~~

~~AT~~

GENERAL REFINING SITE

~~SAVANNAH,~~ CHATHAM COUNTY, GEORGIA

Garden City

TDD# 04-8701-07-1007
TAT# 04-F-

By: ~~TO:~~ SHANE HITCHCOCK, OSC
EPA, REGION IV

~~FROM:~~ WILLIAM H. LUCAS III
TAT, REGION IV
Roy F. Weston, Inc / SPER Division

DATE: 25 JANUARY 1988

Technical Assistance Team
Roy F. Weston, Inc. / SPER Division
100 Atlanta Technology Center
1575 Northside Drive, Suite 120
Atlanta, Georgia 30318

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REPORT OF REMOVAL ACTIVITIES
AT
GENERAL REFINING SITE
SAVANNAH, GEORGIA

I. SITE HISTORY

A. PHYSICAL DESCRIPTION/LOCATION

The General Refining Company abandoned site is located 0.3 miles northwest of U.S. Highway 80 in Garden City, Chatham County, Georgia (Figure 1 - General Site Location Map & Figure 2 - Site Location Map). The 8 acre site is located in the Coastal Plain Province of Georgia which is characterized by sandy, permeable soils and a shallow water table. Surface water in the area was contaminated by wastes from the site during heavy rains and when on-site impoundments overflowed. Contamination of groundwater from infiltration of wastes into the soil was determined to be likely, and oil had entered a railroad ditch on the west side of the site which subsequently drains into the Savannah River. The site is bounded on the south by a 35 home residential community, on the east by a railroad yard, on the north by a wooded area and on the west by a railroad right-of-way (Figure 3 - Site Sketch/Diagram).

B. PAST OPERATIONS

From 1955 until 1978, Mr. W.A. Winburn operated an oil reclaiming facility on the site. The reclaiming process involved heating waste oil to drive off water and aromatics, flocculating solids with sulfuric acid, binding heavy metals by adding kaolin, filtering through press filters and canning of the refined oil. A caustic sulfuric acid sludge and a kaolin sludge containing heavy metals were generated during this process with the sludges being disposed of in four unlined lagoons. A clay filter cake waste was also generated during the waste oil recycling process. This filter cake material was saturated with oil and high in lead and was piled and/or buried on site. The lagoons containing the waste sludges were characteried by a phased separation of sludge, water, and sediment (Attachment A - Photographs).

C. TYPE/SIZE OF DISPOSAL AREAS/WASTE STREAMS

The General Refining site located near Savannah, Georgia, was operated as a waste oil re-refining facility from the early 1950's until 1975. The sulfuric acid used to treat the oil produced an acidic oily sludge and oily filter cake as by-products. The sludge was disposed of in four unlined lagoons, the filter cake was buried or stockpiled on site, and an additional unlined lagoon that had been used as an oil-water separator was backfilled with filter cake and sludge. Additionally, there was also waste oil stored in bulk tanks on site. The total volume of waste was estimated to be in excess of 10,000 tons of material.

Analysis of the waste oil, sludge and filter cake revealed the presence of petroleum compounds and heavy metals including lead (16 - 10,000 ppm) and copper (83 - 190 ppm). PCBs were detected in all samples at low concentrations (< 10 ppm). The lagoon sludge and associated water indicated a pH value of less than 2. In addition,lead, copper, PCBs, and oil & grease were detected in the groundwater beneath the site, ~~thus threatening nearby drinking water supplies~~.

To remedy the ~~situation, site cleanup actions were~~ initiated in the summer of 1985 to ~~stabilize the site~~, secure the facility and explore ~~disposal~~ alternatives.

~~II~~. REMOVAL TECHNOLOGY SELECTION

~~B~~A. ALTERNATIVES EVALUATED

Several treatment/disposal alternatives were considered and evaluated according to cost, acceptable engineering practices, effectiveness, and timeliness. Four separate methods were evaluated which included: 1) Basic Extractive Sludge Treatment (B.E.S.T.), 2) On-site incineration, 3) Off-site incineration, and 4) Landfilling. A breakdown of those alternatives evaluated follow (Attachment B - Action Memorandum).

Alternative	Time Required On Site (days)	Cost
Basic Extractive Sludge Treatment (B.E.S.T.)	119	$2,650,000
On-Site Incineration	173	$7,008,000
Off-Site Incineration	45	$4,844,230
Landfilling	276	$8,560,000

~~B~~C. ALTERNATIVE SELECTED

The Basic Extractive Sludge Treatment (B.E.S.T.), a waste reduction/treatment process which separates the oil, sludge, and solids into their oil, water, and solids components, was chosen as the best mitigative method because it required neither major transportation costs (as in the case of off-site incineration) nor an involved testing and permitting process (as in the case of on-site incineration) (Attachment A - Photographs).

At this time a three-phase approach was implemented to identify any site-specific problems that may have resulted in the system being incompatible with the wastes at the site. Phase I included detailed analyses of all waste streams and pond strata to identify treatment and disposal requirements. Pilot-scale testing was conducted during Phase II to evaluate each component to determine treatment system requirements. Phase III included the mobilization and on-site operation of the mobile B.E.S.T. treatment system.

EPA initiated immediate removal actions on 13 August 1985, to remove hazardous substances resulting from operations at the abandoned waste oil facility. This initial action, which was approved in the amount not to exceed $325,000, included stabilizing acidic oil-sludge lagoons and bulk storage areas, and the identification of alternate technology for treatment and/or disposal of wastes on site.

On 27 September 1985, a budget ceiling increase of $400,000 was authorized to implement the selected alternative technology for a total site ceiling of $725,000. Original estimates of 3,540 tons of wastes on site later nearly tripled to 10,162 tons because of the discovery of an additional buried lagoon and more accurate volume calculations through the use of aerial photography. Handling of this considerable volume increase would require additional on-site time beyond the six month statutory limit, therfore a six month time exemption was requested by OSC Hitchcock in order that removal activities could proceed. It was anticipated that on-site removal activities would be completed in July 1986 assuming the availability of funding and the granting of the six month time exemption for removal activities (Attachment B - Action Memorandum).

III. PHASE I INITIAL MITIGATIVE RESPONSE

A. SAMPLING AND ASSESSMENT

Phase I of the immediate removal actions was initiated at the General Refining Site, Garden City, Georgia, on August 14, 1985. Removal operations were preceded by a preliminary assessment/evaluation survey and composite sampling of the site conducted on August 7, 1985.

The site was separated into six distinct areas for sampling operations with each area being defined as follows: A1 - backfilled lagoon approximately 90 x 97 feet in size; A2 - seven leaking tanks surrounded by a dike; A3 - several buildings and sheds, approximately 50 empty barrels, twelve tanks and a sump some 7 x 7 x 3 feet in size containing oil and water; A4 - sludge/soil mound 2-4 feet high and 58 feet wide x 110 feet long; A5 - three sludge-filled lagoons with pH values of approximately 1; A6 - eight tanks, 25 barrels, fifteen 5-gallon containers and a sludge-filled lagoon.

Eight composite samples were collected from waste oil tanks, sludge lagoons, backfilled lagoons, 55-gallon drums, and a filter cake solids pile for analysis by Savannah Labs with these samples being coded as follows:

GRSC#1 - soil sample, A1 back-filled lagoon
GRSC#2 - soil sample, A4 sludge mound
GRLC#3 - sludge sample, A5 lagoons #1,2,3
GRLC#4 - sludge sample, A6 lagoon #4
GROG#1 - oil sample, A2 tank #2, sump and dike
GRTC#1 - oil sample, A2 tank composite

GRTC#2 - oil sample, A3 tanks #8,9,10,12
GRDC#1 - oil sample, A6 barrels #2,8

On August 19, 1985, additional sampling was conducted on compartmentalized waste oil tanks not previously sampled. Seven grab samples were obtained in order to analyze for copper, lead, PCB's, and volatile organic compounds. These samples were coded as follows and sent to Savannah Labs for analysis:

T6B - A2, tank #6, back compartment
T6F - A2, tank #6, front compartment
T5 - A2, tank #5
T4 - A2, tank #4
T3B - A2, tank #3, back compartment
T2B - A2, tank #2, back compartment
T1B - A2, tank #1, back compartment

On August 22, 1985, eight composite samples were collected from the four sludge lagoons on-site and sent to Resource Conservation Company. These samples were compatibility tested for the extractives sludge treatment system developed by the Resource Conservation Company (RCC) which was selected for utilization during Phase II & III removal operations (Attachment C - Phase I Weston SPER Report).

B. SITE STABILIZATION

In addition to sampling, removal actions addressed during Phase I of the immediate removal operation included:

1) reinforcement of dikes surrounding sludge lagoons, waste oil tanks, and filter cake solids pile to prevent off-site runoff
waste oil tanks, and filter cake solids pile to prevent runoff
2) removal of drums to filter cake pile
3) prevention of runoff from filter cake solids pile by application of visqueen material
4) partial removal of waste oil from storage tanks
5) establishment of access roads to lagoon areas
6) establishment of a fence surrounding the site to prevent unauthorized access
7) addition of sodiuk hydroxide (NaOH) to sludge lagoons in an attempt to neutralize them

Neutralization of the lagoons was attempted by the addition of NaOH, however, it was not achieved due to the unforeseen acidic strength of sludge material in the lagoon sediments.Phase I activities were completed on August 24, 1985 with the ensuing Phase II & III removal operations objectives to include:

1) treatment and disposal of sludge and water from sludge lagoons
2) removal and disposal of filter cake solids pile
3) removal and disposal of contaminated waste oil in

storage tanks and drums
4) reclamation of the waste site

IV. ALTERNATIVE TECHNOLOGY

A. DESCRIPTION OF PROCESS

1. B.E.S.T. SEPARATION

Resorces Conservation Company (RCC) developed and patented the B.E.S.T. process in the mid-1970s as a means of dewatering municipal wastewater sludges. The process was proven to successfully recover solids high enough in nutrients to be sold as animal feed or fertilizer. The low price of these produts combined with the availability of inexpensive disposal alternatives made commercialization uneconomical at the time. The process was not developed further until 1984 when environmental legislation under RCRA escalated hazardous waste disposal costs. As a result, investigation of B.E.S.T. as a method for the treatment of oily sludges was initiated. After an intensive market study, RCC felt that it could provide a totally engineered processing plant at competitive prices to process listed and non-listed oily wastes.

In 1985 RCC built its first full-scale unit. This unit has a nominal capacity of 100 tons/day (wet throughput) and can handle sludges which contain up to 30% oil and up to 40% solids, without modifications (Figure 4 - B.E.S.T. Unit). Actual throughput, however, will vary with the actual composition and chemistry of the sludge (Attachment D - The B.E.S.T. Sludge Treatment Process: An Innovative Alternative Used At A Superfund Site).

The key to the patented B.E.S.T. process is the use of one or more of a family of aliphatic amine solvents to effectively break oil/water emulsions and release bonded water from the sludge. The B.E.S.T. process is designed around the physically unique interactions between triethylamine (TEA), water, and soluble organics (Figure 5 - Aliphatic Amine - Water Solubility Diagram). At temperatures below about 20 C, TEA, water and oil are readily miscible, however, upon heating they become immiscible. When in a single miscible phase, water or TEA soluble constituents, including organic emulsions and oil, mix completely and dissolve in a cold single phase solution. From that cold liquid phase, a residue containing the solids that TEA or water does not dissolve can be physically separated. When heated above 20 C the solids-free mixture separates into a TEA/oil phase and a water phase. These two streams are further processed for solvent recovery, providing a recovered oil stream and a purified water stream (Figure 6 - B.E.S.T. Separation Diagram).

The B.E.S.T. process combines the solvent characteristics of TEA with a number of well known and proven unit process technologies to create the treatment system. However, it is the water/solvent miscibility feature which distinguishes it from other solvent extraction processes.

The specific steps of the B.E.S.T. treatment process run as follows (Figure 7 - Process Overview):

1. The waste to be treated is mixed with TEA, and the resulting mixture cooled below the miscibility point.

2. Solids are removed by centrifuging.

3. The resulting liquid solution is then heated above the miscibilty point and two liquid phases are formed. The liquid phases are separated by decanting the lighter oil/solvent phase from a heavier water phase. Both the oil/solvent phase and the water phase are further purified by steam stripping to recover the valuable solvent.

4. Residual TEA and water are further extracted and recovered from the solids by recentrifuging and drying.

5. The process ends with the residuals: water, which can be treated and discharged like any other waste water; oil, which can be used as fuel or recycled; and solids in the form of a dry powdery residue.

6. The TEA is recovered and continuously recycled for further waste processing.

B. MATERIALS HANDLING AND FINAL DISPOSITION

1. OIL

Using the General Refining site as a prototype for on-site testing of the B.E.S.T. unit as a means of hazardous waste disposal, the three generated waste streams had different ultimate dispositions. Approximately 60,000 gallons of oil was generated from the separation process of the B.E.S.T. unit and stored in bulk storage tanks on-site until a facility was located to accept the oil. Although site operations were completed on 4 April 1987, it was not until the week of 18 September 1987 that the oil was finally accepted by a facility. The prolonged period taken for a facility to accept the oil was due to several factors: 1) residual concentrations of TEA remained in the processed oil even after the solvent extraction process, and 2) an acceptable use for the oil was difficult and often times impossible to determine. However, Eastern Petroleum Company of Warner Robins, Georgia located a facility to accept the oil from the site. The oil was shipped via tanker trucks provided by ERCS contractor HAZTECH to Dillard rail yard where the oil was transferred to Norfolk Southern Railroad tank cars who transported it to its final destination. From this point, the oil went to the Giant Cement Company in Harleyville, South Carolina where it was used for its BTU value to fuel a cement kiln owned and operated by the company. Delcon Industries, handler of Giant's alternate energy sources, approved the oil from provided analytical data and additionally cleared its disposition through South Carolina Department of Health and Environmental Control (SCDHEC).

Processing the hazardous waste at the General Refining site started with front-end materials handling performed by EPA ERCS contractor HAZTECH, Inc. of Atlanta, Georgia. Since the oil fraction was binded in the lagoon sludges, the sludge was pumped out of the ponds, placed into large holding tanks, and neutralized.

Neutralization was accomplished by mechanically mixing the wastes with sodium hydroxide. The raw sludge was blended with the filter cake and backfill solids until the mixture was homogenous and the pH appropriate. The mixture of approximately 70% water, 10% oil and 20% solids was pumped to a sludge storage tank and then pumped to the B.E.S.T. system and processed.

2. WATER

Since the ponds/lagoons were stratified, free water from the ponds was pumped out separately into a holding tank which stored water that was to be processed by the B.E.S.T. system along with the sludge. Depending on the needs of the system, part or all of the free water was at times pumped directly to the on-site water treatment process, bypassing the system altogether.

The product water required further on-site treatment prior to discharge. The water treatment plant was a modular facility using two-stage clarification. The first stage of water treatment consisted of acidifying the water and adding a flocculent and an oil/water emulsion breaker. Solids removal was accomplished in a contact clarifier. Lime was added to increase the pH, alum added to precipitate the heavy metals, in particular lead, and a contact clarifier was used to settle out sludge materials. A centrifuge was used to dewater the clarifier underflows, and the rejected water-treatment sludge returned to the B.E.S.T. system for reprocessing. That water which was not rejected was transferred to a 60K on-site storage pool where it would remain until being picked up by Florida Rock & Tank tanker trucks and transported off-site for further treatment and ultimate disposal at the Union Camp facility in Savannah, Georgia.

3. SOLIDS

The front-end materials handling operation of solids required the use of several types of solids processing equipment. Since all site material neede to be less than 1/4 inch mesh to be processed, the solids pile of filter cake and backfill had to be screened. Difficulties were encountered meeting the 1/4 inch screening requirement. Original efforts were made to pass the filter cake material through a 1/4 inch vibrating dry screen, but the high moisture and oil content in the filter cake material would not allow it to pass readily through the screen. A change was made from the vibrating dry screen to a 1/4 inch hammermill, which crushed material to a desired size. A two inch drag screen was required in conjunction with the hammermill to pre-screen metal and other material that could damage the unit. However, the drag screen limited the the rate of filter cake processing and

backed up the feed materials handling operations.

Screening of the sludge from the ponds, in contrast to the filter cake solids was successfully accomplished using a vibrating screen. The sludge was pumped from the ponds by a submerged double diaphram pump into the vibrating screen where it was mixed with sodium hydroxide. The screened sludge and caustic was dropped into a mixing tank where they were mixed with the filter cake solids. The mixture was pumped into a storage tank to await treatment in the B.E.S.T. system. The equipment was able to process material with viscosities in excess of 1,000,000 centipoises (Attachment E - Enviresponse, Inc. Test Report).

Due to time and resource constraints, problems were never resolved sufficiently to allow processing of the filter cake solids. Difficulty with keeping the solids in suspension for any length of time and the inability of the B.E.S.T. system to handle sand mixed in with the solids prevented extraction of the filter cake. Approximately 7,000 cubic yards of hazardous solids remain on site and are presnetly awaiting disposal. These solids include both filter cake solids as well as solids generated during the solidification/backfilling process of all on-site lagoons. These hazardous solids have been covered with tarps and sewn together to prevent any off-site runoff while determination of ultimate disposal options are sought.

C. PROBLEMS/SOLUTIONS

1. MECHANICAL

The B.E.S.T. unit itself was not free of mechanical difficulties. Some problem areas that developed were the centrifuge seals, the dryer solids conveying system, and control of the solvent stripper.

Triethylamine, the solvent used in the extraction process, can be flammable in the presence of air (see Attachment F - Site Safety Plan), which required that all unit processes be sealed from the atmosphere and kept under a nitrogen blanket. Since centrifuges are not inherently leak tight, special seals were designed by the manufacturer and purged with nitrogen. These seals however did not work well and when they failed they caused the bearings of the centrifuge to fail as well. After many centrifuge breakdowns, a suitable material for the seals was discovered. Although the centrifuge did not fail after implementing new seals, some triethylamine continued to leak.

In order to transport the dried solids out of the dryer unit it required that a constant solids level be maintained at the exit chute for the solids, and that a constant pressure be maintained in the dryer. The original design failed to achieve either requirement, and as a result, the solids could not be transported from the unit without exposure to dusting and possible TEA vapors. To remedy the problem, a larger chute was built with a level control to control the speed of the conveyor. Also, the dryer was detached from the main condenser, thus making it an

independent unit process with its own pressure control.

The solvent still process controls originally were designed to control the energy balance of the stripping column. This was theoretically achieved by controlling steam heat to the reboiler which continuously heated the oil that was circulated at the bottom of the column. Since the still design was based on sripping triethylamine, steam was used to control the balance in the column, but control of the steam proved to be difficult. As a result, the steam control was changed from a temperature-based control system to a proportional control system to remedy the problem (Attachment E - Enviresponse, Inc. Test Report).

V. OVERVIEW

A. PROBLEMS/CORRECTIONS

The B.E.S.T. process is essentially a phase separation process which can separate oily sludges into their component fractions: oil, water, and solids. However it has been found and observed that the efficiency of the system can be affected by the presence of certain componenets in the feed sludge such as emulsification agents. Another major problem with the system is its inability to handle any material over a 1/4 inch mesh in size. However, this problem could be easily resolved by appropriate front-end materials handling equipment capable of bringing the materials to appropriate size without slowing the feed process to the unit.

This process was not intended to destroy contaminants in the sludge, nor to reduce the contaminant's toxicity, mobility or volume. However, it is possible that as the fraction separations take place, certain contaminants can be removed from the original sludge and concentrated in a specific phase, such as PCBs concentrated in the oil fraction, and metals concentrated in the solids fraction. This contaminant separation and concentration could be used to advantage in further treatment of the products, such as incineration of the oil, landfilling of the solids, and discharge of the water to a treatment facility.

A 24-hour testing of the B.E.S.T. system and its capabilities/limitations was conducted by Enviresponse, Inc. under contract to EPA in Region X. The following is its recommendations based on the above mentioned test period:

> It is the recommendation of this report that the B.E.S.T. process be further tested to continue to accrue useful data to determine the system's actual applicability to a variety of feedstocks, beyond bench test results and the General Refining site operation, and to further determine the system's efficiency in separating feedstocks into their oil, solids, and water fractions, and its efficiency in isolating contaminants into a specific fraction so that ultimate disposal techniques for the fractions can

be determined. As time allows, gathering of operational data should be undertaken to determine the reliability and operational costs of the system. Actual full scale effects of components in the feedstocks that could affect the maximum efficiency of the system should be tested, and systems limitations defined. Continued operation and testing under controlled conditions to accumulate additional operational and performance data is highly recommended, as the B.E.S.T.extraction technology shows excellent promise for use as an on-site treatment technology not only for sludges, but for other oily hazardous waste feedstocks (see Attachment E - Enviresponse, Inc. Test Report).

B. AMOUNT OF MATERIAL TREATED

During the winter of 1986-1987, RCC operated its full-scale B.E.S.T. solvent extraction sludge treatment system at the General Refining Superfund site. After delays and modifications on the unit design, the system was able to treat approximately 3,700 tons of oily sludges left from the petroleum refining operations. Although the system was unsuccessful at treating the solid filter cake material, it proved to be more than capable as a fractionating process to separate the oil from the water as demonstrated by the total volume treated (Figure 8 - Sludge Processed Diagram).

C. CONTRACTING PROBLEMS AS CONTRIBUTIONS TO UNRESOLVED TECHNICAL PROBLEMS

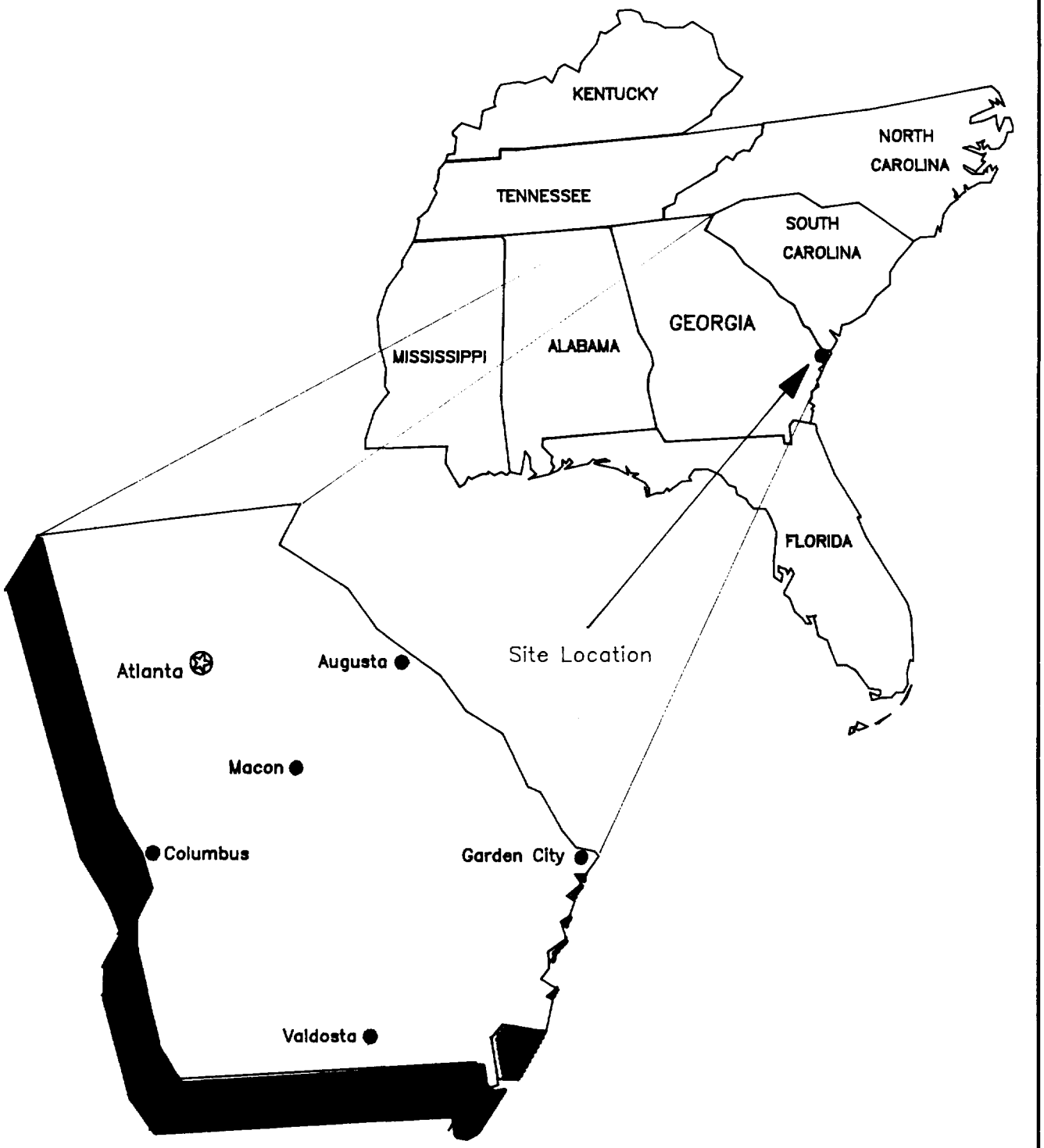
Cost overrun at the General Refining site were due in large part to restraints of the contracting mechanism under which the project was required to be administered. That is, material handling and support operations were the responsibility of the ERCS prime contractor HAZTECH on a time and materials basis. If these costs could have been negotiated into a unit rate with RCC, any cost overruns could have been avoided. Cost overruns were minimized however by developing a RCC subcontract on a unit rate cost. RCC received approximately $ 300,000 for material treated, but spent in excess of $ 3 million trying to get the system operational (Figure 9 - Cost Breakdown Pie Graph).

D. FUTURE PERFORMANCE

Although the site was left with hazardous substances untreated as in the case of the filter cake solids, the site itself was stabilized and the primary threat of groundwater contamination was significantly reduced by eliminating the liquid/sludge wastes on site utilizing the B.E.S.T. system.

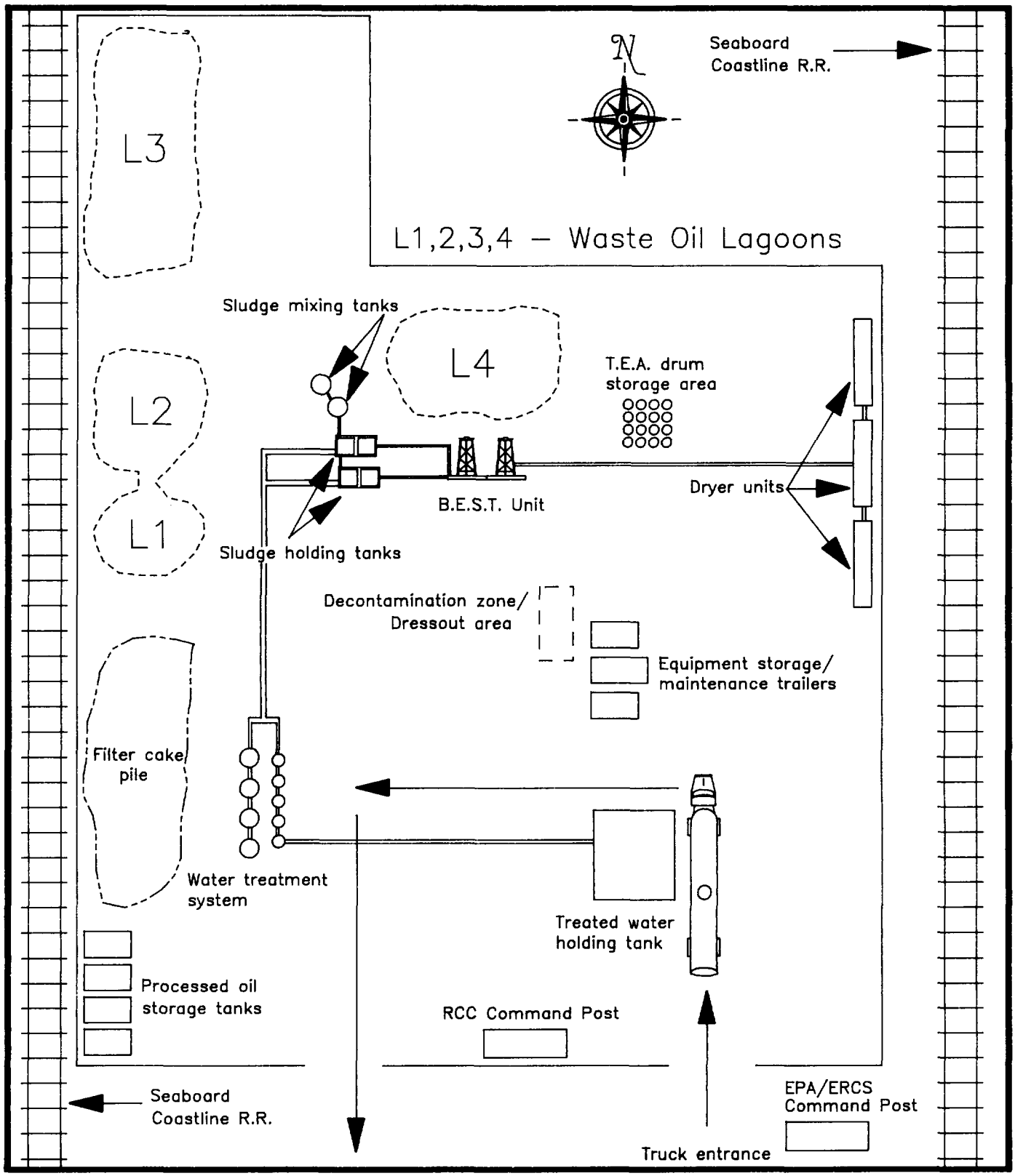
The benefits from this technology will be realized as its use is implemented on future sites. Front-end materials handling equipment first identified on this site for example is currently

being used at the Peak Oil site in Tampa, Florida. In addition, Region V EPA is considering use of the B.E.S.T. process, where the time and resources used to develop this technology at the General Refining site may be realized.



E.P.A. Region IV
Weston T.A.T. Activity Location
TDD 04-8701-07-1007
Location Map; General Refining Site
Garden City, Chatham County, Georgia

EPA

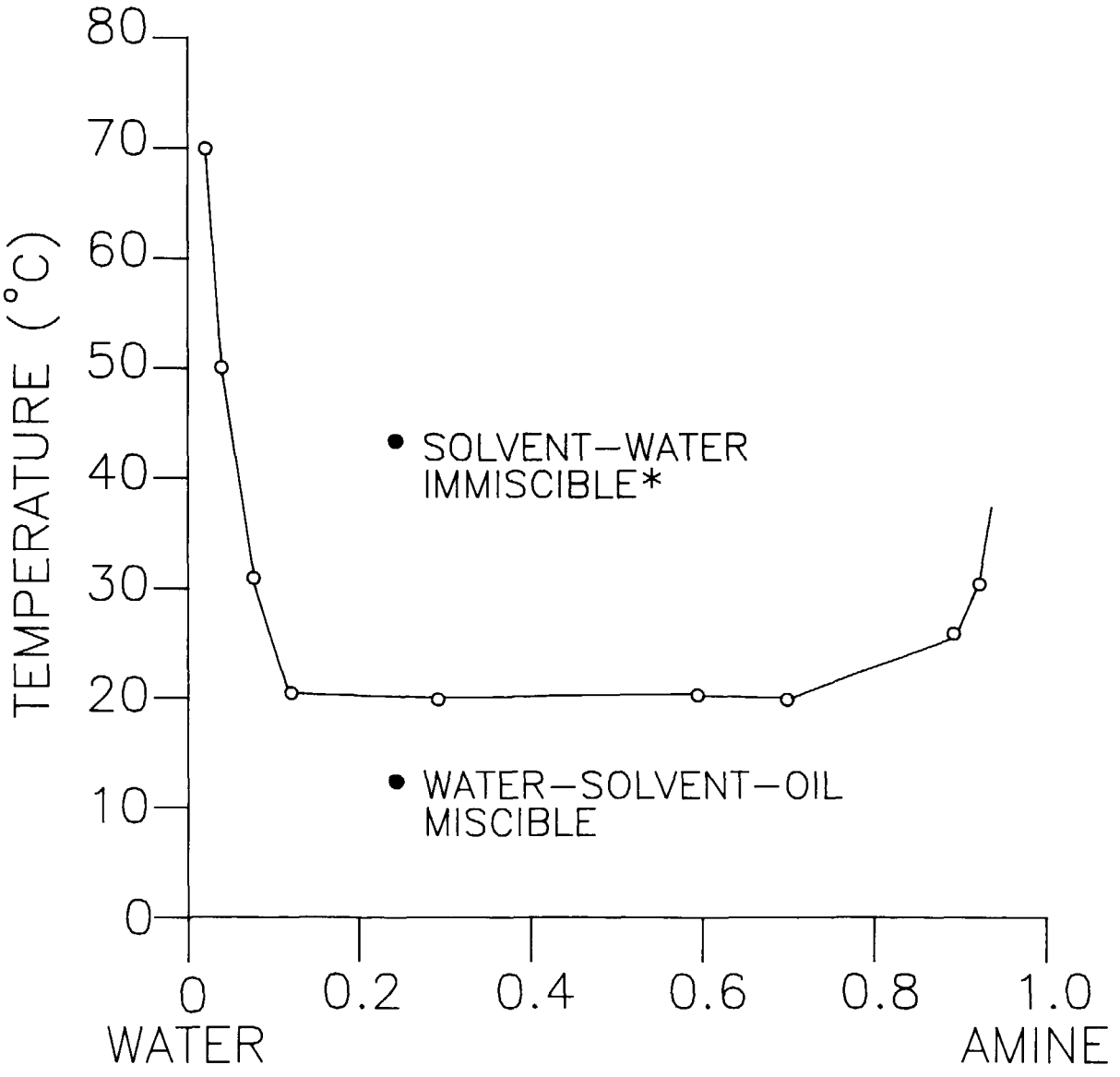


WESTON TAT ACTIVITY: Site Diagram SITE: General Refining Site

Garden City, Georgia TDD NUMBER: 8701-07

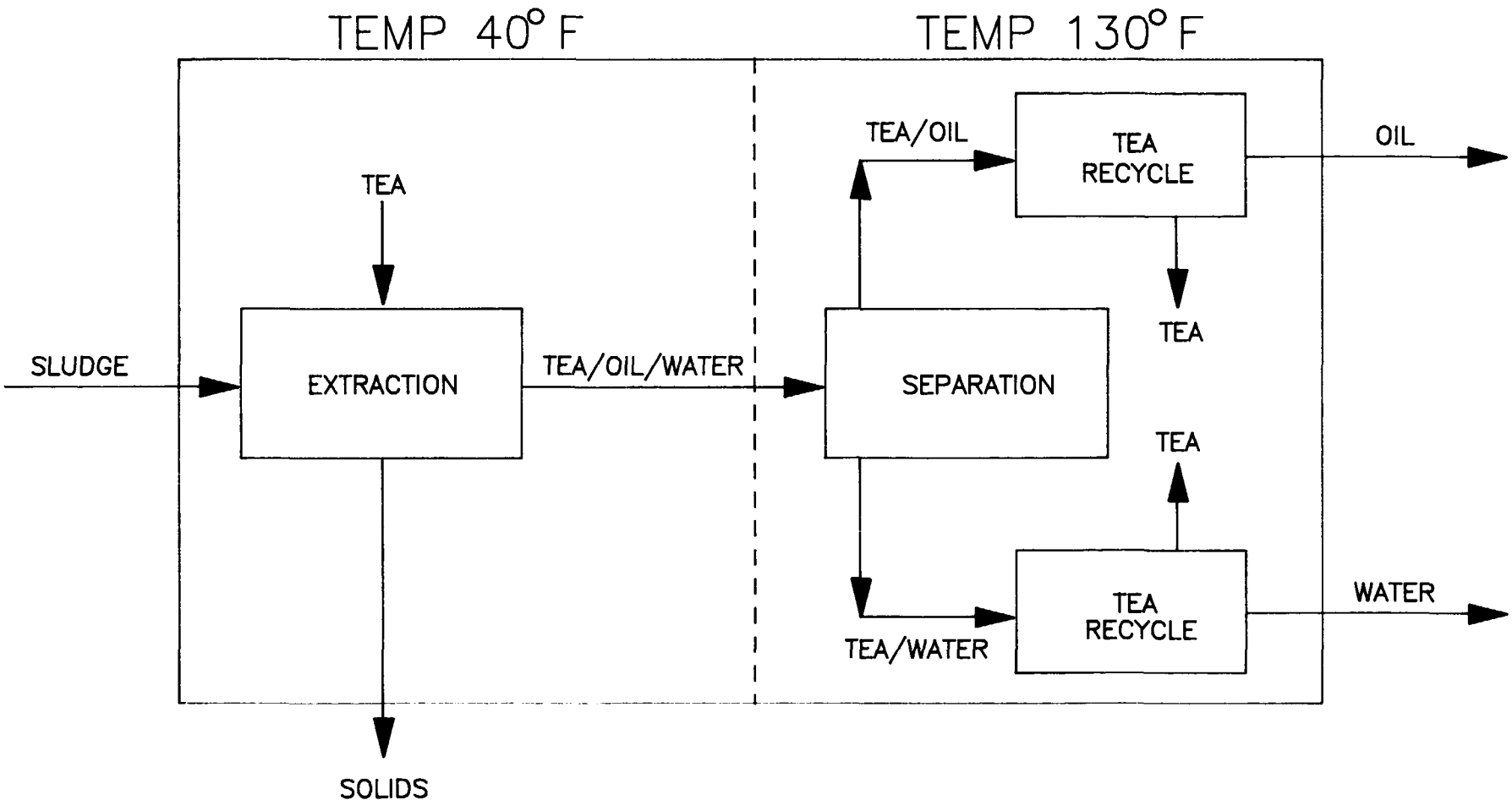
DATE: 23 December 1987

ALIPHATIC AMINE – WATER SOLUBILITY

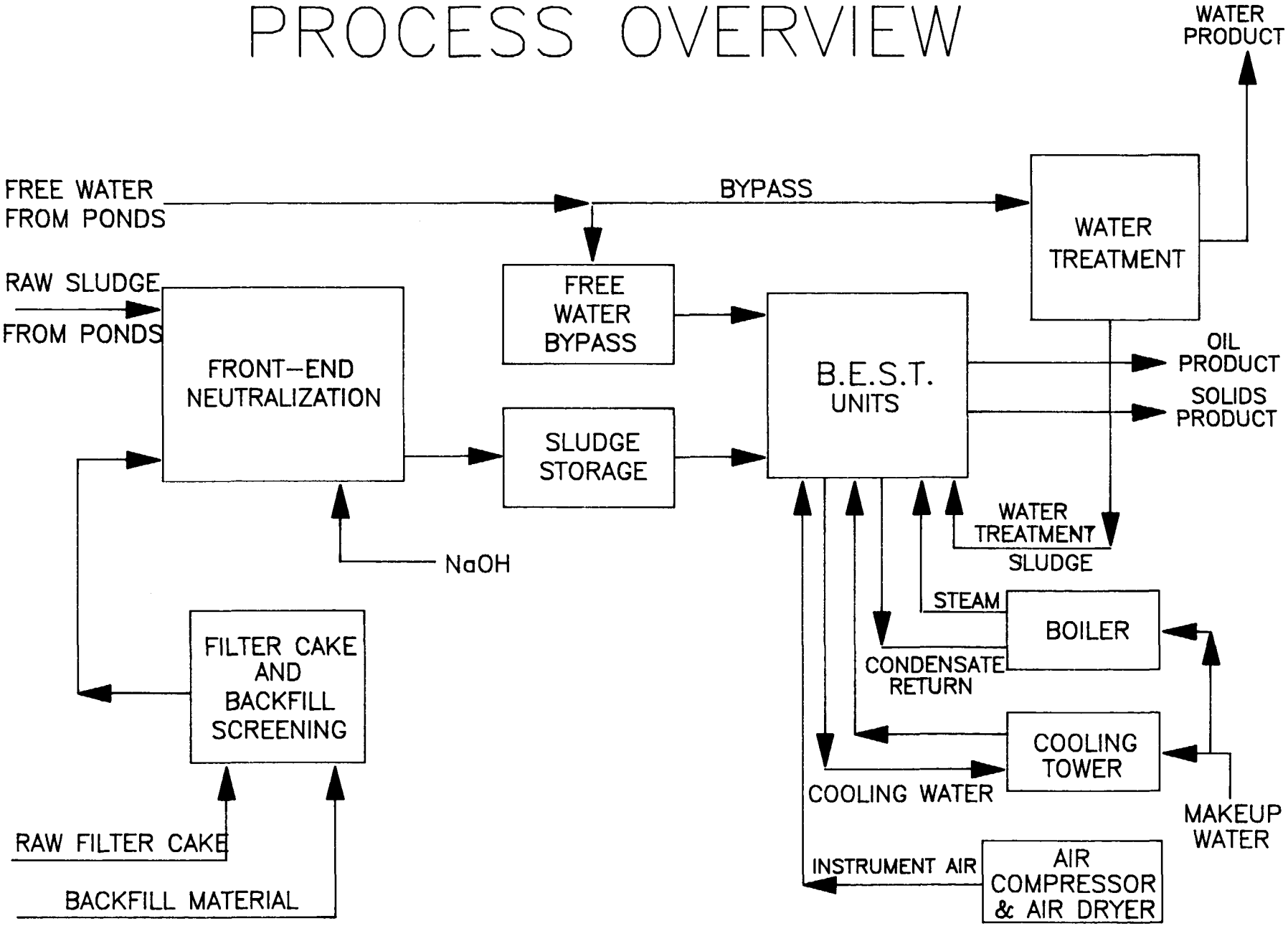


* OIL STAYS WITH SOLVENT DURING SEPARATION

B.E.S.T. SEPARATION DIAGRAM



PROCESS OVERVIEW



SLUDGE PROCESSED
GENERAL REFINING SITE, SAVANNAH, GEORGIA

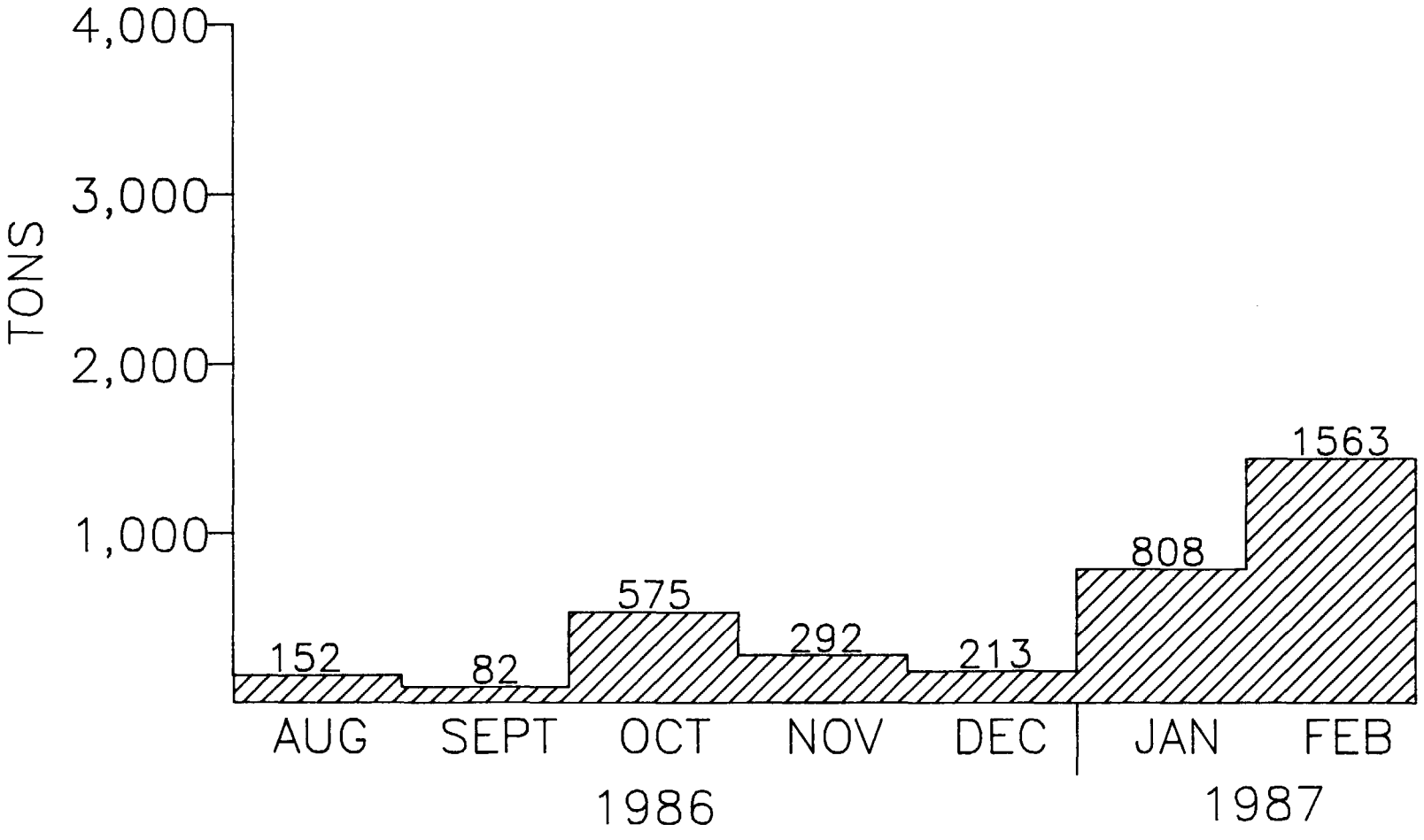


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TABLE OF CONTENTS

FACT SHEET CERCLA

SITE:	General Refining
SIZE:	Approximately 8 acres
LOCATION:	Garden City, Chatham County, Georgia
ACTIVATION/APPROVAL DATE:	00
PROJECT DATES:	
DESCRIPTION:	The General Refining Site was a former oil re-refining operation which utilized an acidic process for the reclamation of used oils. Approximately 4 acres were contaminated with oil/grease and lead. The removal action involved the excavation and treatment of oils, sludge and soils from several storage lagoons and bulk tanks located on the site. Contaminated waters, sludge and oils were treated utilizing the Resources Conservation Company's B.E.S.T. System (Basic Extractive Sludge Treatment). Soils and filter cake materials which were unable to be treated by the B.E.S.T. unit were fixated using a pugmill during 1989.
HAZARDOUS MATERIALS:	Lead and oil/grease
QUANTITIES REMOVED AND TREATED:	3,700 tons oily sludges (B.E.S.T. Unit) 60,000 gallons oil (B.E.S.T. Unit) 00,000 tons soil (Fixation Phase)
O.S.C.:	Shane Hitchcock, EPA Region IV, Atlanta, Georgia
REMOVAL CONTRACTOR:	HAZTECH, Atlanta, Georgia (B.E.S.T. Phase) O.H.M., Findlay, Ohio (Fixation Phase)
B.E.S.T. UNIT CONTRACTOR:	Resources Conservation Company
PROJECT CEILING:	
PROJECT COST:	

REPORT OF REMOVAL ACTIVITIES

AT

GENERAL REFINING SITE

GARDEN CITY, CHATHAM COUNTY, GEORGIA

I. SITE HISTORY

A. PHYSICAL DESCRIPTION/LOCATION

The General Refining Company abandoned site is located 5 miles west of Savannah, Georgia and 0.3 miles northwest of U.S. Highway 80 in Garden City, Chatham County, Georgia (Figure 1 - General Site Location Map & Figure 2 - Site Location Map). The site is approximately 8 acres in size and relatively flat with only several feet of relief over the site. Surface water in the area was contaminated by wastes from the site during heavy rains and when on-site impoundments overflowed. Contamination of groundwater from infiltration of wastes into the soil was determined to be likely, and oil had entered a railroad ditch on the west side of the site which subsequently drains into the Savannah River. The site is bounded on the south by a 35 home residential community, on the east by a railroad yard, on the north by a wooded area and on the west by a railroad right-of-way (Figure 3 - Site Sketch/Diagram).

B. HYDROGEOLOGY

The 8 acre site is located in the Pamlico Terrace of the Coastal Plain Province of Georgia. The site is immediately underlain by

rock units of the Cypresshead Formation (Pliocene) which is characterized as consisting of sandy, permeable soils and a shallow water table. In the area domestic water is supplied solely by wells which tap the Suwanee Limestone (Oligocene) and Crystal River (Upper Eocene) Formations. The top of these aquifers range in depth from 246 to 309 feet below Chatham County.

C. TYPE/SIZE OF DISPOSAL AREAS/WASTE STREAMS

The acidic oily sludge was disposed of in four unlined lagoons, the filter cake was buried and stockpiled on site. An additional unlined lagoon that had been used as an oil-water separator was backfilled with filter cake and sludge and covered with native soil. There was approximately 60,000 gallons of waste oil stored in bulk tanks and lagoons on site. The total volume of solid waste was estimated to be in excess of 10,000 tons of materials.

Analyses of the waste oil, sludge and filter cake revealed the presence of petroleum compounds and heavy metals including lead (16 - 10,000 ppm) and copper (83 - 190 ppm). PCBs were detected in all samples at low concentrations (> 10 ppm). The lagoon sludge and associated water indicated a pH value of less than 1. In addition, lead, copper, PCBs, and oil & grease were detected in the groundwater beneath the site.

II. REMOVAL TECHNOLOGY SELECTION

A. ALTERNATIVES EVALUATED

Several treatment/disposal alternatives were considered and evaluated according to cost, acceptable engineering practices, effectiveness, and timeliness. four separate methods were evaluated which included: 1) Basic Extractive Sludge Treatment (B.E.S.T.), 2) On-site incineration, 3) Off-site incineration, and 4) Landfilling. A breakdown of those alternatives evaluated follow (Attachment B - Action Memorandum).

Alternative	Time Required On Site (days)	Cost
Basic Extractive Sludge Treatment (B.E.S.T.)	119	$2,650,000
On-Site Incineration	173	$7,008,000
Off-Site Incineration	45	$4,844,230
Landfilling	276	$8,560,000

B. ALTERNATIVE SELECTED

The Basic Extractive Sludge Treatment (B.E.S.T.), a waste reduction/treatment process which separates the oil, sludge, and solids into their oil, water, and solids components, was chosen as the best mitigative method. The B.E.S.T. process was identified as the most economical alternative and the most environmentally effective because the oil fraction of the waste was recycled as a final product.

A three-phase approach was implemented to identify the feasibility of the process and any site-specific problems that may have resulted in the system being incompatible with the waste at the site. Phase I included detailed analyses of all waste streams and pond strata to identify the components of the wastes and bench scale tasting to determine if the phased separation would occur. Pilot-scale testing was conducted during Phase II on a small scale unit to evaluate each process component to determine treatment system requirements. Phase III included the mobilization and on-site operation of the mobile B.E.S.T. treatment system.

III. REMOVAL ACTION PHASE 1

A. SAMPLING AND ASSESSMENT

The General Refining Site was referred to EPA Region IV by the Georgia Environmental Protection Division following a site inspection and sampling investigation which was conducted on August 7, 1985.

The site was separated into six distinct areas for sampling operations with each area being defined as follows: A1 - backfilled lagoon approximately 90 x 97 feet in size; A2 - seven oil storage tanks; A3 - several buildings and sheds, approximately 50 empty barrels, twelve tanks and a sump some 7 x 7 x 3 feet in size containing oil and water; A4 - sludge/soil mound 2-4 feet high and 58 feet wide x 110 feet long; A5 - three sludge-filled lagoons

with pH values of approximately 1; A6 - eight tanks, 25 barrels, fifteen 5-gallon containers and a sludge-filled lagoon.

Eight composite samples were collected from waste oil tanks, sludge lagoons, backfilled lagoons, 55-gallon drums, and a filter cake solids pile for analysis with these samples being coded as follows:

GRSC#1 - soil sample, A1 back-filled lagoon
GRSC#2 - soil sample, A4 sludge mound
GRSC#3 - sludge sample, A5 lagoons #1,2,3
GRSC#4 - sludge sample, A6 lagoon #4
GROG#1 - oil sample, A2 tank @2, sump and dike
GRTC#1 - oil sample, A2 tank composite
GRTC#2 - oil sample, A3 tanks #8,9,10.12
GRDC#1 - oil sample, A6 barrels #2,8

On August 19, 1985, additional sampling was conducted on compartmentalized waste oil tanks not previously sampled. Seven grab samples were obtained in order to analyze for copper, lead, PCB's and volatile organic compounds. These samples were coded as follows and sent to Savannah Labs for analysis:

T6B - A2, tank #6, back compartment
T6F - A2, tank #6, front compartment
T5 - A2, tank #5
T4 - A2, tank #4
T3B - A2, tank #3, back compartment

T2B - A2, tank #2, back compartment

T1B - A2, tank #1, back compartment

On August 22, 1985, eight composite samples were collected from the four sludge lagoons on-site and sent to Resource Conservation Company. These samples were compatibility tested for the extractives sludge treatment system developed by the Resources Conservation Company (RCC) which was selected for utilization during Phase II & III removal operations (Attachment C - Phase I Weston SPER Report).

B. SITE STABILIZATION

In addition to sampling, removal actions addressed during Phase I included:

1) reinforcement of dikes surrounding sludge lagoons, wastes oil tanks, and filter cake solids pile to prevent off-site runoff
2) removal of drums to filter cake pile
3) prevention of runoff from filter cake solids pile by application of visqueen material
4) partial removal of waste oil from storage tanks
5) establishment of access roads to lagoon areas
6) establishment of a fence surrounding the site to prevent unauthorized access
7) addition of sodium hydroxide (NaOH) to sludge lagoons in

attempt to neutralize them

8) Identity treatment alternatives

Neutralization of the lagoons was attempted by the addition of NaOH, however, it was not achieved due to the unforeseen acidic strength of sludge material in the lagoon sediments and uncontrolled mixing in place. Phase I activities were completed on August 24, 1985.

IV. ALTERNATIVE TECHNOLOGY

A. DESCRIPTION OF PROCESS

1. B.E.S.T.K SEPARATION

Resources Conservation Company (RCC) developed and patented the B.E.S.T. process in the mid-1970s as a means of dewatering municipal wastewater sludges. The process was proven to successfully recover solids high enough in nutrients to be sold as animal feed or fertilizer. The low price of these products combines with the availability of inexpensive disposal alternatives made commercialization uneconomical a the time. The process was not developed further until 1984 when environmental legislation under RCRA escalated hazardous waste disposal costs. As a result, investigation of B.E.S.T. as a method for the treatment of oily sludges was initiated.

In 1985 RCC built its first full-scale unit. This unit has nominal capacity of 100 tons/day (wet throughput) and was designed to

process sludges which contain up to 30% oil an dup to 49% solids, without modifications (Figure 4 - B.E.S.T. Unit). Actual throughput, however, will vary with the actual composition and chemistry of the sludge (The B.E.S.T. Sludge Treatment Process: An Innovative Alternative Used At A Superfund Site).

The key to the patented B.E.S.T. process is the use of one or more of a family of aliphatic amine solvents to effectively break oil/water emulsions and release bonded water form the sludge. The B.E.S.T. process is designed around the physically unique interactions between triethylamine (TEA), water, and soluble organics. At temperatures below about 20 C, TEA, water and oil are readily miscible, however, upon heating they become immiscible. (Figure 5 - aliphatic Amine - Water Solubility Diagram). When in a single miscible phase, water TEA soluble constituents, including organic emulsions and oil, mix completely and dissolve in a cold single phase solution. From that cold liquid phase, a residue containing the solids that TEA or water does not dissolve can be physically separated. When heated above 20 C the solids-free mixture separates into a TEA/oil phase and a water phase. These two streams are further processed for solvent recovery, providing a recovered oil stream and a purified water stream (Figure 6 - B.E.S.T. Separation Diagram).

The B.E.S.T. process combines the solvent characteristics of TEA with a number of well known and proven unit process technologies to create the treatment system. However, it is the water/solvent

miscibility feature which distinguishes it from other solvent extraction processes.

The specific steps of the B.E.S.T. treatment process run as follows (Figure 7 - Process Overview):

1. The waste to be treated is mixed with TEA, and the resulting mixture cooled below the miscibility point.

2. Solids are removed by centrifuging.

3. The resulting liquid solution is then heated above the miscibility point and two liquid phases are formed. The liquid phases are separated by decanting the lighter oil/solvent phase from a heavier water phase. Both the oil/solvent phase and the water phase are further purified by steam stripping to recover the valuable solvent.

4. Residual TEA and water are further extracted and recovered from the solids by recentrifuging and drying.

5. The process ends with the residuals: water, which can be treated and discharged like any other waste water; oil, which can be used as fuel or recycled; and solids in the form of a dry powdery residue.

6. The TEA is recovered and continuously recycled for further

waste processing.

Using the General Refining site as a prototype for on-site testing of the B.E.S.T. unit as a means of hazardous waste disposal, the three generated waste streams had different ultimate disposition. Approximately 60,000 gallons of oil was generated from the separation process of the B.E.S.T. unit and stored in bulk storage tanks on-site. Although site operations were completed on 4 April 1987, it was not until the week of 18 September 1987 that the oil was finally accepted by a facility. The prolonged period taken for a facility to accept the oil was die to several factors: 1) residual concentrations of TEA remained in the processed oil even after the solvent extraction process, and 2) an acceptable use for the oil was difficult and often times impossible to determine. However, Eastern Petroleum company of Warner Robins, Georgia located a facility to accept the oil from the site. The oil was shipped via tanker trucks provided by ERCS contractor HAZTECH to Dillard rail yard where the oil was transferred to Norfolk Southern Railroad tank cars and transported to its final destination. From this point, the oil went to the Giant Cement Company in Harleyville, South Carolina where it was used for its BTU value to fuel a cement kiln owned and operated by the company. Delcon Industries, handler of Giant's alternate energy sources, approved the oil form provided analytical data and additionally cleared its disposition through South Carolina Department of Health and Environmental control (SCDHEC).

Processing the hazardous waste at the General Refining site started with front-end materials handling performed by EPA ERCS contractor HAZTECH, Inc. of Atlanta, Georgia. Since the oil fraction was binded in the lagoon sludges, the sludge was pumped out to the ponds, placed into large holding tanks, and neutralized.

Neutralization was accomplished by mechanically mixing the wastes with sodium hydroxide. The raw sludge was blended with the filter cake and backfill solids until the mixture was homogenous and the pH appropriate. The mixture of approximately 70% water, 10% oil and 20% solids was pumped to a sludge storage tank and then pumped to the B.E.S.T. system and processed.

2. WATER

Since the ponds/lagoons were stratified, free water from the ponds was pumped out separately into a holding tank which stored water that was to be processed by the B.E.S.T. system along with the sludge. Depending on the needs of the system, part or all of the free water was a times pumped directly to the on-site water treatment process, bypassing the system altogether.

The product water required further on-site treatment prior to discharge. The water treatment plant was a modular facility using two-stage clarification. The first stage of water treatment consisted of acidifying the water and adding a flocculent and an oil/water emulsion breaker. Solids removal was accomplished in a

contact clarifier. Lime was added to increase the pH, alum added to precipitate the heavy metals, in particular lead, and a contact clarifier was used to settle out sludge materials. A centrifuge was used to dewater the clarifier underflows, and the rejected water-treatment sludge returned to the B.E.S.T. system for reprocessing. That water which was not rejected was transferred to a OK on-site storage pool where it would remain until being picked up by tanker trucks and transported off-site for further treatment and ultimate disposal at an industrial facility in Savannah, Georgia.

3. SOLIDS

The front-end materials handling operation of solids required the use of several types of solids processing equipment. Since all site material needed to be less than 1/4 inch mesh to be processed, the solids pile of filter cake and backfill had to be screened. Difficulties were encountered meeting the 1/4 inch screening requirement. Original efforts were made to pass the filter cake material through a 1/4 inch vibrating dry screen, but the high moisture and oil content in the filter cake material would not allow it to pass readily through the screen. A change was made form the vibrating dry screen to a 1/4 inch crusher which crushed material to a desired size. A two inch drag screen was required in conjunction with the hammermill to pre-screen metal and other material that could damage the unit. However, the drag screen limited the rate of filter cake processing and backed up the feed

materials handling operations.

Screening of the sludge from the ponds, in contrast to the filter cake solids was successfully accomplished using a vibrating screen. The sludge was pumped form the ponds by a submerged double diaphragm pump into the vibrating screen where it was mixed with sodium hydroxide. The screened sludge and caustic was dropped into a mixing tank where they were mixed with the filter cake solids. The mixture was pumped into a storage tank to await treatment in the B.E.S.T. system. The equipment was able to process material with viscosities in excess of 1,000,000 centipoises.

Due to time and resource constraints, problems were never resolved sufficiently to allow processing of the filter cake solids. Difficulty with keeping the solids in suspension for any length to time and the inability of the B.E.S.T. system to handle sand mixed in with the solids prevented extraction of the filter cake. Approximately 7,000 cubic yards of hazardous solids remained on site and were awaiting disposal. These solids include both filter cake solids as well as solids generated during the solidifaction/backfilling process of all on-site lagoons. These hazardous solids were covered with tarps and sewn together to prevent any off-site runoff while determination of ultimate disposal options were sought.

B. MECHANICAL PROBLEMS/SOLUTIONS

Some problem areas that developed were the centrifuge seals, the dryer solids conveying system, and control of the solvent stripper. Triethylamine, the solvent used in the extraction process, can be flammable in the presence of air (see Attachment F - Site Safety Plan), which required that all unit processes be sealed form the atmosphere and kept under a nitrogen blanket. Since centrifuges are not inherently leak tight, special seals were designed by the manufacturer and purged with nitrogen. These seals however did not work well and when failure occured they caused the bearings of the centrifuge to fail as well. After many centrifuge breakdowns, a suitable material for the seals was discovered. Although the centrifuge did not fail after implementing new seals, some triethylamine continued to leak.

In order to transport the dried solids out of the dryer unit it required that a constant solids level be maintained at the exit chute for the solids, and that a constant pressure be maintained in the dryer. The original design failed to achieve either requirement, and as a result, the solids could not be transported from the unit without exposure to dusting and possible TEA vapors. To remedy the problem, a later chute was built with a level control to control the speed of the conveyor. Also, the dryer was detached from the main condenser, thus making it an independent unit process with its own pressure control.

The solvent still process controls originally were designed to control the energy balance of the stripping column. This was theoretically achieved by controlling steam heat to the reboiler which continuously heated the oil that was circulated at the bottom of the column. Since the still design was based on stripping triethylamine, steam was used to control the balance in the column, but control of the steam proved to be difficult. As a result, the steam control was changed from a temperature-based control system to a proportional control system to remedy the problem (Attachment E - Enviresponse, Inc. Test Report).

V. OVERVIEW

A. PROBLEMS/CORRECTIONS

The B.E.S.T. process is essentially a phase separation process which can separate oily sludges into their component fractions: oil, water, and solids. However it has been found and observed that the efficiency of the system can be affected by the presence of certain components in the feed sludge such as emulsification agents. Another major problem with the system is its inability to handle any material over a 1/4 inch mesh in size. However, this problem could be easily resolved by appropriate front-end materials handling equipment capable of bringing the materials to appropriate size without slowing the feed process to the unit.

This process was not intended to destroy contaminants in the sludge, nor to reduce the contaminant's toxicity, mobility or

volume. However, it is possible that as the fraction separations take place, certain contaminants can be removed from the original sludge and concentrated in a specific phase, such as PCBs concentrated in the oil fraction, and metals concentrated in the solids fraction. This contaminant separation and concentration could be used to advantage in further treatment of the products, such as incineration of the oil, landfilling of the solids, and discharge of the water to a treatment facility.

A 24-hour testing of the B.E.S.T. system and its capabilities/limitations was conducted by Enviresponse, Inc. under contract to EPA in Region X. The following is its recommendations based on the above mentioned test period:

> It is the recommendation of this report that the B.E.S.T. process be further tested to continue to accrue useful data to determine the system's actual applicability to a variety of feedstocks, beyond bench test results and the General Refining site operation, and to further determine the system's efficiency in separating feedstocks into their oil, solids and water fractions, and its efficiency in isolating contaminants into a specific fraction so that ultimate disposal techniques for the fractions can be determined. As time allows, gathering of operational data should be under-

taken to determine the reliability and operational costs of the system. Actual full scale effects of components in the feedstocks that could affect the maximum efficiency of the system should be tested, and systems limitations defined. Continued operation and testing under controlled conditions to accumulate additional operational and performance data is highly recommended, as the B.E.S.T. extraction technology shows excellent promise for use as on-site treatment technology not only for sludges, but for other oily hazardous waste feedstocks (see Attachment E - Enviresponse, Inc. Test Report).

B. AMOUNT OF MATERIAL TREATED

During the winter of 1986-1987, RCC operated its full-scale B.E.S.T. solvent extraction sludge treatment system at the General Refining site. After delays and modifications on the unit design, the system was able to treat approximately 3,700 tons of oily sludges left from the petroleum re-refining operations. although the system was unsuccessful at treating the solid filter cake material, it proved to be more than capable as a fractionating process to separate the oil from the water as demonstrated by the total volume treated (Figure 8 - Sludge Processed Diagram).

C. CONTRACTING PROBLEMS AS CONTRIBUTIONS TO UNRESOLVED TECHNICAL PROBLEMS

Cost overrun at the General Refining site were due in large part to restraints of the contracting mechanism under which the project was required to by administered. That is, material handling and support operations were the responsibility of the ERCS prime contractor HAZTECH on a time and materials basis. If these costs could have been negotiated into a unit rate with RCC, any cost overruns could have been avoided. Cost overruns were minimized however by developing a RCC subcontract on a unit rate cost. RCC received approximately $300,000 for material treated, but spent in excess of $3 million trying to get the system operational (Figure 9 - Cost Breakdown Pie Graph).

D. FUTURE PERFORMANCE

Although the site was left with hazardous substance untreated as in the case of the filter cake solids, the site itself was stabilized and the primary threat of groundwater contamination was significantly reduced by eliminating the liquid/sludge wastes on site utilizing the B.E.S.T. system.

The benefits from this technology will be realized as its use is implemented on future sites. Front-end materials handling equipment first identifies on this site for example is currently being used at the Peak Oil site in Tampa, Florida. In addition,

Region V EPA is considering use of the B.E.S.T. process, where the time and resources used to develop this technology at the General Refining site may be realized.

VI. STORAGE TANK REMOVAL\FIXATION PROCESS PHASE

A. STORAGE TANK REMOVAL ACTIONS

The removal of the storage tanks on the site began on 17 May 1989. A composite sample of the three tanks which contained materials on the site was taken on 18 May 1989 by ERCS E. Steele. Analytical work was performed by Savannah Laboratories. The samples were analyzed for PCB's, TCLP and EP Tox lead and oil/grease. The chain of custody and analytical results follow in Attachment #, Volume #. TCLP lead was found at 2 ppm. EP Tox lead had a value of 0.36 ppm. Oil and grease were found at 550 ppm. The PCB Aroclor-1260 was detected at a level of 4.7 ppb

The tanks with contents that remained on site were holding materials consisting of mostly oil with some sludges and rainwater. Solidification of the tank contents was accomplished with the addition of kiln dust (Photo#). Tank content solidification operations began on 17 May 1989 and concluded on 27 May 1989. The tanks were then cut using hydraulic shears attached to a trackhoe (Caterpillar 225) and the solidified contents removed and bulked with other stockpiled wastes at the site (Photos# , and video footage Region IV EPA). The scrap metal portions of the tank were decontaminated by ERCS using a 3,000 p.s.i. water laser

and sold to a local recycler, Clayton Eason. Tank cutting and decon operations were conducted from 17 May 1989 to 13 June 1989.

B. FIXATION PROCESS

1. MATERIAL ASSESSMENT\PREPARATION

The ERCS contractor O.H. Materials was tasked by Region IV EPA to perform fixation tests on the material at the site to determine the components necessary to fixate the wastes. The work was performed under Delivery Order #7404-04-023, issued on 20 January 1988. The samples were then analyzed for all TCLP compounds. The material chosen based upon the treatability testing was Pozzalime, a kiln dust and silicate compound generated as a byproduct in cement kilns. The supplier of the fixating agent was JTM Industries of Marietta, Georgia.

The three piles of contaminated material were sampled again on 22 May 1989 by TAT member Neal McElveen, to determine if the condition of the material remained the same and to verify the effectiveness of the mixing ratio. One grab sample was taken from each of the pile and taken to Savannah Laboratories by ERCS. The samples were analyzed for EP Tox lead, total lead and oil/grease. The chain of custody and analytical results follow in Attachment #, Volume #. EP Tox lead was found in pile #1 at 35 ppm and in piles #2 and #3 at 20 ppm. Total lead was found in pile #1 at 19,000 ppm, in pile #2 at 12,000 ppm and in pile #3 at 15,000 ppm. Oil and grease levels ranged from 27,000 ppm to 102,000 ppm.

Before fixation of the contaminated materials could begin it had to be reduced in size to facilitate the mixing process. This was accomplished with the aid of a power screen using a inch mesh. The power screen was mobilized to the site on 23 May 1989 and assembled from 24 to 25 May 1989. Power screen operations continued until all materials to be processed were completed on 11 August 1989.

2. PUGMILL PRODUCTION

Fixation operations were performed using a pugmill on a time and materials basis from the ERCS prime contractor O.H. Materials. The pugmill consisted of a feed hopper, a weight conveyor, the pugmill itself, a silo and a stacking conveyor. The feed hopper featured augers to break-up any large soil "clumps" which may have developed since power screening. The weight conveyor served as a feed control to the pugmill or mixing area, functioning as a weight scale. The pugmill itself consisted of a holding tank with two mixing shafts and a baffle which dictated the retention or mixing time of materials. A silo was located overhead through which the fixating agent was introduced to the pugmill. A stacking conveyor transported the material after leaving the pugmill into dump trucks for placement in the monolith area. A unique feature of this system was the ability to control the feed of materials, water and fixating agents into the pugmill as well as control the retention time thus making it useful for a variety of moistures and materials. The pugmill and associated machinery were mobilized to

the site on 30 May 1989. The setup and initial calibration procedures were undertaken from 30 May to 10 June 1989. The pugmill was put into production on 07 June 1989 for calibration purposes. The following text is a daily summary of the pugmill operation and production.

08 June 1989: The pugmill was utilized for five hours treating 661.5 cubic yards of contaminated soil with 472.5 cubic yards of kiln dust. The treated material was placed in the monolith grid area designated A-1.

09 June 1989: No pugmill production due to inclement weather.

10 June 1989: The pugmill was utilized for four hours treating 80.5 cubic yards of contaminated soil with 57.5 cubic yards of kiln dust. The treated material was placed in the monolith grid area designated A-2.

11 June 1989: No pugmill production due to inclement weather.

12 June 1989: The pugmill was utilized for five hours treating 4.2 cubic yards of contaminated soil with 3.0 cubic yards of kiln dust. The treated material was placed in the monolith grid area designated B-1.

13 June 1989: The pugmill was utilized for three hours treating 140.0 cubic yards of contaminated soil with 100.0 cubic yards of

kiln dust. The treated material was placed in the monolith grid area designated B-1. At 0950 hours TAT member Chuck DuBois sampled the pugmill product. The sample was taken in a teflon mold and allowed to cure 72 hours. The sample was then transported to Savannah Laboratories and analyzed for structural integrity and EP TOX lead at a detection limit of 200 ppb. The level was found to be below the detection limit. The chain of custody and analytical results follow in Attachment #, Volume #.

14 June 1989: The pugmill was utilized for six hours treating 155.4 cubic yards of contaminated soil with 111.0 cubic yards of kiln dust. The treated material was placed in the monolith grid area designated B-3.

15 June 1989: The pugmill was utilized for six hours treating 204.0 cubic yards of contaminated soil with 100.0 cubic yards of kiln dust. The treated material was placed in the monolith grid area designated B-3.

16 June 1989: The pugmill was utilized for six hours treating 222.0 cubic yards of contaminated soil with 140.0 cubic yards of kiln dust. The treated material was placed in the monolith grid area designated D-2 and sampled by TAT member Chuck DuBois. The sample was taken in a teflon cylinder mold and allowed to cure for 72 hours. The sample was then taken to Savannah Laboratories and analyzed for structural integrity and EP TOX lead at a detection limit of 50 ppb. The levels of EP TOX lead were found to be below

the detection limits. The chain of custody and analytical results follow in Attachment #, Volume #.

17, 18, 19, and 20 June 1989: Pugmill production stopped due to inclement weather consisting of severe thundershowers.

21 June 1989: The pugmill was utilized for one hour treating 14.0 cubic yards of contaminated soil with 11.0 cubic yards of kiln dust. The treated material was placed in the monolith grid area designated B-4.

22 June 1989: The pugmill was utilized for four hours treating 142.8 cubic yards of contaminated soil with 101.0 cubic yards of kiln dust. The treated material was placed in the monolith grid area designated C-1.

23 June 1989: The pugmill was utilized for five and one half hours treating 122.5 cubic yards of contaminated soil with 87.5 cubic yards of kiln dust. The treated material was placed in the monolith grid area designated C-2. An experimental batch of fixated material was produced on this date for the purpose of testing the viability of a new kiln dust-soil mixture. The batch of material was produced by mixing 16 ounces of contaminated soil with 8 ounces of kiln dust. Water was added until the moisture passed a visual inspection. The sample was taken and procured by Chuck DuBois, Region IV TAT. The samples were delivered to Savannah Laboratories on 26 June 1989 by Brian Meyer, Region IV

TAT. The sample was analyzed for structural integrity and EP TOX lead at a detection limit of 50ppb. The result was found to be below this detection limit. The chain of custody and analytical results follow in Attachment #, Volume

24 and 25 June 1989: No pugmill production due to weather.

26 June 1989: The pugmill was utilized for six hours treating 216.1 cubic yards of contaminated soil with 154.4 cubic yards of kiln dust. The treated material was placed in the monolith grid area designated C-3.

27 June 1989: The pugmill was utilized for eight hours treating 283.0 cubic yards of contaminated soil with 202.2 cubic yards of kiln dust. The treated material was placed in the monolith grid area designated C-4.

28 June 1989: The pugmill was utilized for eight hours treating 262.4 cubic yards of contaminated soil with 187.4 cubic yards of kiln dust. The treated material was placed in the monolith grid area designated C-5.

29 June 1989: The pugmill was utilized for eight hours treating 208.2 cubic yards of contaminated soil with 148.6 cubic yards of kiln dust. The treated material was placed in the monolith grid area designated D-1.

30 June 1989: TAT member Brian K. Meyer sampled the pugmill product using a Teflon plug mold at 0800 hours. Problems were encountered with the output stacking conveyor's bearing, and as a result production ceased following the procurement of the sample. The sample was allowed to cure 24 hours and was analyzed for structural integrity and EP-Tox lead at a detection limit of 50 ppb. The results were found to be below the established detection limit. The chain-of-custody with analytical report are found in Attachment #, Volume #.

01, 02, 03 and 04 July 1989: Work ceased due to mechanical problems and holiday period.

05 July 1989: Pugmill down due to bearing being put on backorder.

06 July 1989: The pugmill was utilized for six hours treating 336.84 cubic yards of contaminated soil with 120.3 cubic yards of kiln dust. The treated material was placed in the monolith grid area designated A-3. During this production day TAT member Brian Meyer sampled the pugmill product using a Teflon plug mold. The sample cured for the appropriate 24 hours and was transported to Savannah Laboratories and analyzed for structural integrity and EP-TOX LEAD to drinking water standards with less than 50 ppb results. The chain-of-custody and a copy of the analytical report follow in Attachment #, Volume #.

07 July 1989: The pugmill was utilized for seven hours treating

574.28 cubic yards of contaminated soil with 205.1 cubic yards of kiln dust. The treated material was placed in the monolith grid areas designated B-3 and B-4.

08 July 1989: The pugmill was utilized for seven hours treating 305.2 cubic yards of contaminated soil with 109.0 cubic yards of kiln dust. The treated material was placed in the monolith grid area designated C-3A.

09 July 1989: Sunday holiday.

10 July 1989: The pugmill was utilized for seven hours treating 508.84 cubic yards of contaminated soil with 181.73 cubic yards of kiln dust. The treated material was placed in the monolith grid area designated D-3. This material was sampled by TAT member C. DuBois using a Teflon plug mold and was allowed to cure for 24 hours. The sample was taken to Savannah Laboratories and analyzed for structural integrity and EP-TOX lead at a detection limit of 50 ppb. Results were found to be below the established limits. The chain-of-custody and a copy of the analytical report follow in Attachment #, Volume #.

11 July 1989: The pugmill was utilized for eight hours treating 385.28 cubic yards of contaminated soil with 137.6 cubic yards of kiln dust. The treated material was placed in the monolith grid areas designated C-3A and C-3B.

12 July 1989: The pugmill was utilized for eight hours treating 555.8 cubic yards of contaminated soil with 198.5 cubic yards of kiln dust. The treated material was placed in the monolith grid area designated D-3B.

13 July 1989: The pugmill was utilized for nine hours treating 595.0 cubic yards of contaminated soil with 212.5 cubic yards of kiln dust. The treated material was placed in the monolith grid area designated G-3.

14 July 1989: The pugmill was utilized for seven and three tenths hours of use treating 611.8 cubic yards of contaminated soil with 218.5 cubic yards of kiln dust. The treated material was placed in the monolith grid area designated H-3 and sampled by TAT member Chuck DuBois using a Teflon plug mold and allowing to cure for 24 hours. The samples were taken to Savannah Laboratories for analysis of EP-TOX lead and structual integrity. Results were below the 50 ppb detection limit. The chain-of-custody and a copy of the analytical report follow in Attachment #, Volume #.

15 July 1989: The pugmill was utilized for five hours treating 317.24 cubic yards of contaminated soil with 113.3 cubic yards of kiln dust. The treated material was placed in the monolith grid area designated I-3.

16 July 1989: Sunday holiday.

17 July 1989: The pugmill was utilized for eight hours treating 693.74 cubic yards of contaminated soil with 247.76 cubic yards of kiln dust. The treated material was placed in the monolith grid area designated J-3.

18 July 1989: The pugmill was utilized for seven hours treating 551.68 cubic yards of contaminated soil with 197.03 cubic yards of kiln dust. The treated material was placed in the monolith grid area designated J-3B. TAT member Chuck DuBois sampled the fixated material at 0903 hours. The sample was taken in a teflon mold and allowed to cure for 72 hours. The sample was then taken to Savannah laboratories and analyzed for structural integrity and EP TOX lead at a detection limit of 200 ppb. The level was found to be 18 ppm, verbal notification recieved on 24 July 1989. The chain of custody and analytical results follow in Attachment #, Volume #.

19 July 1989: The pugmill was utilized for seven hours treating 520.5 cubic yards of contaminated soil with 185.9 cubic yards of kiln dust. The treated material was placed in the monolith grid area designated K-3.

20 and 21 July 1989: No pugmill production, site activities include decon and grading of monolith area.

22 and 23 July 1989: Off-weekend holiday.

24 July 1989: Verbal notification recieved on pugmill sample from

18 July 1989. The level was found to be above the acceptable standards.

25 July 1989: TAT Meyer and OSC Rigger sampled the 60' by 70' area of the monolith in response to the pugmill sample of 18 July 1989 which exceeded the target cleanup goal of 5 ppm. This area of the monolith is where fixated material from 14 July (date of last acceptable sample was 14 July) through 19 July 1989 was placed. One sample was composited from 5 sample points, placed in a 32 ounce jar and transported to Savannah Laboratories and analyzed for EP TOX lead at a detection limit of 50 ppb. The level was found to be 7.0 ppm. The chain of custody and analytical results follow in Attachment #, Volume #. A series of follow-up confirmatory product samples were taken by ERCS on 28 July 1989 to delineate the sub-standard material, see 28 July 1989 sampling section for review and results.

26 and 27 July 1989: No pugmill production due to waiting on analytical data, grading of monolith area continues.

28 July 1989: ERCS J. Kilbarger and T. Robinson sampled the 60' by 70' area of the monolith which had been shown to be sub-standard. The area was subdivided into 5 sections, each of which represents the placement of one days fixated material. The sample for each of the five sections was composited from four sample points, placed in a 32 ounce jar and transported to Savannah Laboratories. The samples were analyzed for EP TOX lead at a detection limit of 50

ppb. Four of the five sample areas exceeded the target cleanup goal of 5 ppm. Chain of custody and analytical results may be found in Attachment #, Volume #. These areas were then excavated and retreated.

29 July - 01 August 1989: No pugmill production, grading in monolith area continued.

02 August 1989: No pugmill production, confirmatory soil sampling activities ongoing.

03 August 1989: Excavation of previously treated materials in monolith area conducted.

04 August 1989: The pugmill was utilized for nine hours treating 145.4 cubic yards of soil with 103.9 cubic yards of kiln dust. The treated material was placed in the monolith grid area designated H-3. TAT member Brian Meyer sampled the contaminated soil before entry into the pugmill and the finished product after passing through the pugmill. The two samples were taken to Savannah Laboratories and analyzed for structural integrity and EP TOX lead at a detection limit of 50 ppb. Structural integrity was performed on the finished pug-mill product. The result of the contaminated soil pile was 11 ppm and the finished product was less than the detection limit. The chain of custody and analytical results follow in Attachment #, Volume #.

05 August 1989: The pugmill was utilized for four and a half hours treating 91.5 cubic yards of contaminated soil with 65.35 cubic yards of kiln dust. The treated material was placed in the monolith grid area designated I-3.

06 August 1989: Sunday holiday.

07 August 1989: No pugmill production, excavation of contaminated soil undertaken.

08 August 1989: No pugmill production, power screen moved to site and setup to process contaminated soil.

09 August 1989: No work completed due to rain and wet conditions.

10, 11 and 12 August 1989: No pugmill production, power screening of soils conducted.

13 August 1989: Sunday holiday.

14, 15 and 16 August 1989: No work completed due to rain and wet conditions.

17 August 1989: The pugmill was utilized for seven hours treating 520.5 cubic yards of contaminated soil with 185.9 cubic yards of kiln dust. The treated material was placed in the monolith grid area designated K-3. TAT member Chuck DuBois sampled the pugmill

product at 1555 hours. The sample was taken in a teflon mold and allowed to cure 24 hours. The sample was taken to Savannah Laboratories and analyzed for structural integrity and EP TOX lead at a detection limit of 50 ppb. The level was found to be below the detection limit. The chain of custody and analytical results follow in Attachment #, Volume #.

18 August 1989: The pugmill was utilized for three hours treating 49.14 cubic yards of contaminated soil with 38.9 cubic yards of kiln dust. The treated material was placed in the monolith grid area designated I-3C.

19 and 20 August 1989: No work completed due to weekend.

21, 22 and 23 August 1989: No pugmill production due to wet conditions, grading in monolith area continued.

24 August 1989: The pugmill was utilized for four and a half hours reprocessing 157.3 cubic yards of material with an additional 124.8 tons of kiln dust. TAT member Brian Meyer sampled the pugmill product at 1100 hours. The sample was taken in a teflon mold and allowed to cure 24 hours. The sample was taken to Savannah Laboratories and analyzed for structural integrity and EP TOX lead at a detection limit of 50 ppb. The level was found to be below the detection limit. The chain of custody and analytical results follow in Attachment #, Volume #.

25 August 1989: The pugmill was utilized for seven and a half hours reprocessing 284.9 cubic yards of material with an additional 226.1 tons of kiln dust. TAT member Brian Meyer sampled the pugmill product at 1300 hours. The sample was taken in a teflon mold and allowed to cure 24 hours. The sample was taken to Savannah Laboratories and analyzed for structural integrity and EP TOX lead at a detection limit of 50 ppb. The level was found to be below the detection limit. The chain of custody and analytical results follow in Attachment #, Volume #.

26 August 1989: The pugmill was utilized for six hours reprocessing 137.1 cubic yards of material with an additional 99.5 tons of kiln dust. TAT member Brian Meyer sampled the pugmill product at 1050 hours. The sample was taken in a teflon mold and allowed to cure 24 hours. The sample was taken to Savannah Laboratories and analyzed for structural integrity and EP TOX lead at a detection limit of 50 ppb. The level was found to be below the detection limit. The chain of custody and analytical results follow in Attachment #, Volume #.

3. REVIEW OF PERFORMANCE

The pugmill was useful in treating approximately 00,000 tons of lead contaminated soil at the General Refining Site.. An advantage of the pugmill was the ability to control the input of the various products and fixating agents as well as dictate the retention time of the materials in the mixing portion of the process. This

enables the unit to be very useful for handling a variety of materials, as well as a range in moistures of materials.

Several problems were encountered in the supply of materials to the pugmill during production. The amount of water needed to supply the pugmill during production exceeded the capacity of the facility well at the site. This problem was remedied by constructing a 20K pool to serve as a reservoir for peak demand times during the day.

Large pieces or "clumps of soil" would disable the system occasionally causing shut-down of the unit. This problem may be avoided in the future if the power screen were to be attached as a direct feed into the pugmill, avoiding stockpiling of soils between the procedures and exposure to weathering and the elements. This was initially planned for the General Refining Site but the power sreen's output exceeded the pugmill's input capabilities.

The inability to keep the supply of the fixating agent consistent was another problem encountered with the process. Due to the fixating agent being produced as a by-product, supply was not sufficient at times. The trucking contractor, Santee Carriers utilized tanker trucks which had exhaust powered blowers to off-load the tankers. This proved to be innefficient at times during high production when the pugmill's demand for the fixating agent exceeded the truck's ability to supply the material. Two "pig" tanker silos were placed on-site to increase the on-site storage capacity to resolve this problem.

Several problems were encountered with the supply of materials to the pugmill during periods of very high production. These problems were resolved by increasing the storage capacities of the materials on the site. Overall the pugmill was found to be a very effective and efficient tool for the fixation process.

C. CONFIRMATORY SAMPLING ACTIVITIES

1. SOUTHWEST TANK FIELD SOIL SAMPLING

On 14 July 1989 OSC Don Rigger and TAT member Chuck DuBois sampled the southwest field where tanks were located originally on the site (Figure #). Composite samples were taken at 1 foot to 2 feet depths and also at 3 feet to 4 feet depths and composited through mixing. All samples were analyzed by Savannah Laboratories for EP-TOX lead. The results are shown in Table #, Figure #. The chain-of-custody and the analytical report are in Attachment #, Volume #.

2. LAGOON SAMPLING

On 18 July 1989 OSC Rigger and TAT DuBois conducted sampling efforts in the former lagoon areas. Samples were taken continuously to a depth of four feet and composited through mixing. A total of three samples from the three lagoons were taken to Savannah Laboratories and analyzed for EP TOX lead at a detection limit of 200 ppb. The lagoon #1 sample had 0.46 ppm, lagoon #2 had 0.36 ppm, and lagoon #3 had 0.23 ppm of lead. The analytical

results and chain of custodies follow.

3. DITCH SEDIMENT AND SURFACE SOIL SAMPLING

On 19 July 1989 OSC Rigger and TAT DuBois sampled the surface soil and sediment in the ditch located on the south of the site adjacent to the Central of Georgia railroad. The samples were taken at 1443 hours, composited through mixing, and taken to Savannah laboratories and analyzed for EP TOX lead at a detection limit of 200 ppb. The sediment sample had 1.0 ppm and the surface soil sample had 0.76 ppm of lead. The chain of custody and analytical results follow in Attachment #, Volume #.

4. COMPREHENSIVE CONFIRMATORY SOIL SAMPLING

A series of 14 confirmatory soil samples were taken on 25 and 26 July 1989 by ERCS E. Castle, E. Steele and N. Tymus. The site was gridded into 100 feet squares and 5 point composite samples were taken from each of the grid squares. These composite samples were taken continuously to a depth of four feet below the land surface. For the locations of the sampling areas see the sampling grid map (Figure #). The samples were procured and taken to Savannah Laboratories and analyzed for EP TOX lead at a detection limit of 50 ppb. The results of the analytical data may be seen in Table #, (Figure #). A problem was encountered with the sample taken from grid E-1 which contained 7.3 ppm of EP TOX lead. This area was subdivided and resampled on 02 August 1989 by ERCS Kilbarger and

Yates.

ERCS J. Kilbarger and U. Yates resampled grid E-1 following the unacceptable results recieved on 01 August 1989. The 100 feet by 100 feet grid was subdivided into four 50 feet by 50 feet areas (Figure #). Composite samples were taken for each area from 0-2 feet and 2-4 feet for a total number of eight samples. The samples were procured and transported to Savannah Laboratories and analyzed for EP TOX lead at a detection limit of 50 ppb. Area A had 10 ppm in the 0-2 feet sample and 13 ppm. in the 2-4 feet sample. Area B had 9.0 ppm in the 0-2 feet sample. The remaining samples exhibited levels which were below the action limit of 5 ppm (Table #, Figure #). The chain of custody and analytical results follow in Attachment #, Volume #.

The formentioned areas exhibiting levels above the established cleanup criteria were excavated beginning on 07 August 1989. The power screen was mobed to the site again on 08 August 1989. Treatment of the soils began on 17 August and concluded on 26 August 1989. A review of the time and materials that were involved in the process is included in the pugmill production review.

VII. REVEGETATION\GRASSING ACTIVITIES

On 11 June 1990 ERCS personnel were mobilized to the site for the purpose of revegetating or grassing the site. Final grading of the monolith area was also accomplished at this time. Grading operations were unable to be completed in 1989 due to heavy rains preceeding and during Hurricane Hugo. A section of the chain-link fence (approximately 100 feet) was stolen from the site and was replaced during the grassing activities. Work on the fence was conducted by ERCS, TAT and on-scene EPA personnel utilizing materials at the site.

The grassing was performed by an ERCS subcontractor, South Georgia Landscaping Company, Incorporated. Nutrients were added to the soil in the form of 5-10-15 fertilizer (400 lbs per acre) and ammonium nitrate (100 lbs per acre). These materials were then "disced" into the soil to facilitate mixing. Seed consisted of hulled bermuda (30 lbs per acre) and brown top millet (10 lbs per acre). In addition, pine straw was placed as a mulch cover to prevent erosion or predation of the seed. Grassing activities were concluded on 14 June 1990.

VII. WELL ABANDONMENT\PLUGGING

The facility well on the site was abandoned or plugged on 20 July 1990 by ERCS subcontractor Layne-Atlantic. The well extended to a depth of approximately 150 feet below the land's surface. The casing was pulled from the well and cement grout was circulated to the surface with the aid of a tremie pipe. The work was completed

in accordance with requirements for well abandonment procedures.